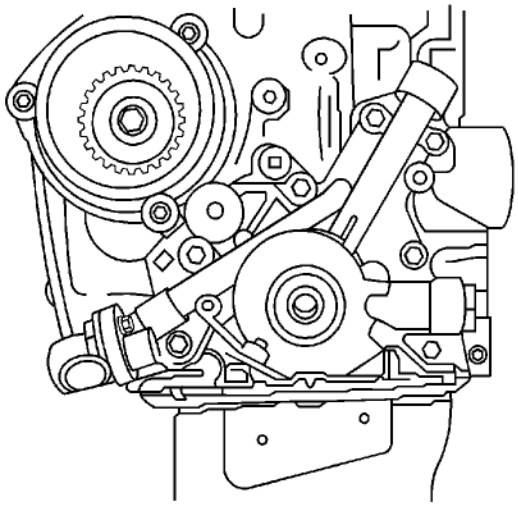
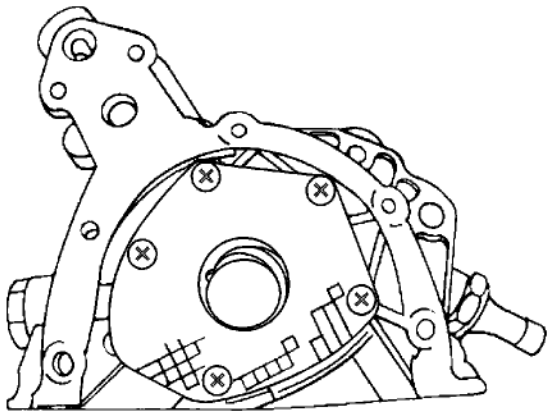
Oil Pump Cleaning and Inspection

Warning: Refer to Safety Glasses Warning in the Preface section.



1. Clean the oil pump and the engine block gasket mating surfaces.
2. Remove the safety relief valve bolt.
3. Remove the safety relief valve and the spring.
4. Remove the oil pump-to-crankshaft seal.



5. Remove the oil pump rear cover bolts.

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6. Remove the rear cover.
7. Clean the oil pump housing and all of the parts.
8. Inspect all of the parts for signs of wear. Refer to Engine Mechanical Specifications.
9. Coat all of the oil pump parts with clean engine oil.
10. Reinstall all of the oil pump parts.

Caution: Refer to Fastener Caution in the Preface section.

Caution: Fill oil pump cavities with petroleum jelly prior to installation. This will ensure that there is oil pressure immediately on start-up and will prevent engine damage.

11. Install the oil pump rear cover and the bolts.

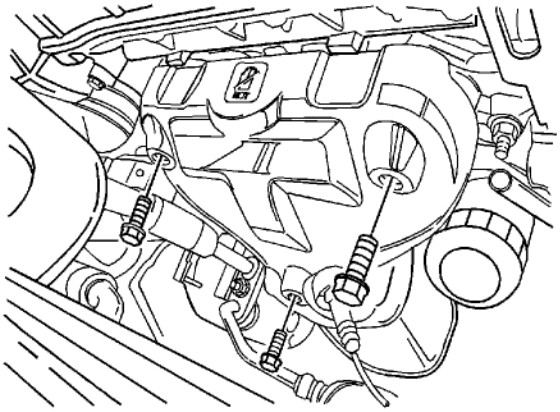
Tighten
Tighten the oil pump rear cover bolts to 6 N·m (53 lb in).

12. Install the safety relief valve, the spring, the washer, and the bolt.

Tighten
Tighten the oil pump safety relief valve bolt to 30 N·m (22 lb ft).

Exhaust Manifold Removal

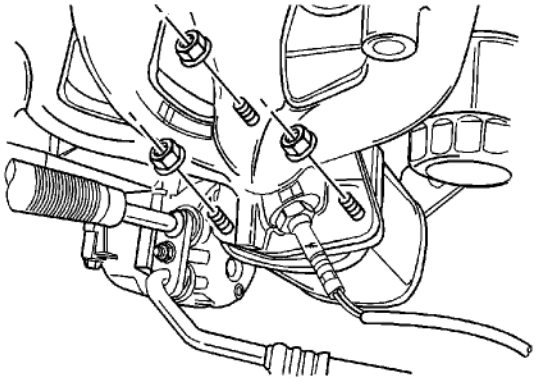
Warning: Refer to Battery Disconnect Warning in the Preface section.



1. Disconnect the negative battery cable.

   Caution: Refer to Oxygen Sensor Caution in the Preface section.

2. Disconnect the oxygen sensor connector.
3. Remove the exhaust manifold heat shield.



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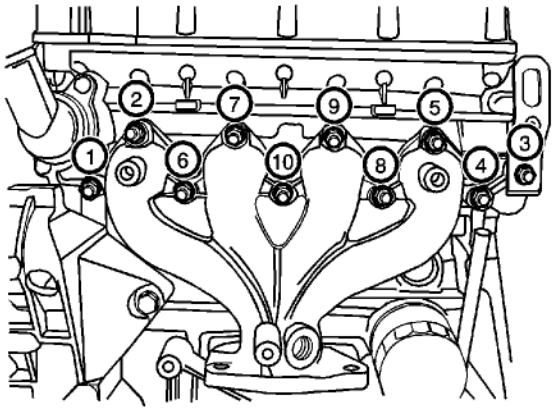
4. Remove the exhaust manifold nuts from the pup converter.

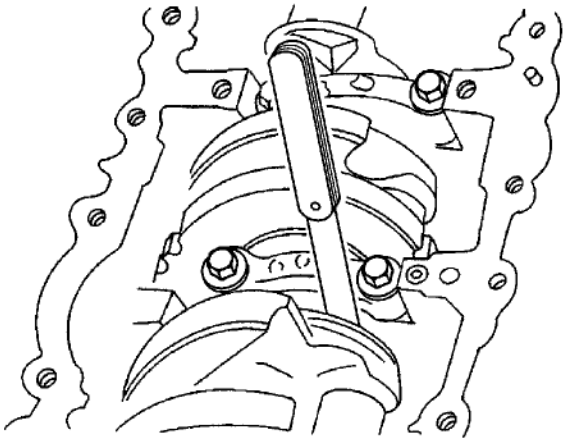


5. Remove the exhaust manifold retaining nuts in the sequence shown and remove the exhaust manifold.
6. Remove the exhaust manifold gasket.
7. Clean the sealing surfaces of the exhaust manifold and the cylinder head.

Crankshaft and Bearing Cleaning and Inspection

Special Tools

- J 45059 Angle Meter
- KM-470-B Angular Torque Gage



1. Coat the crankshaft bearings with engine oil.
2. Install the upper crankshaft bearings into the engine block crankshaft journals.
3. Install the lower crankshaft bearings into the crankshaft bearing caps.
4. Install the crankshaft.
5. Inspect the crankshaft end play with the crankshaft bearings installed.
6. Check for permissible crankshaft end play. Refer to Engine Mechanical Specifications.

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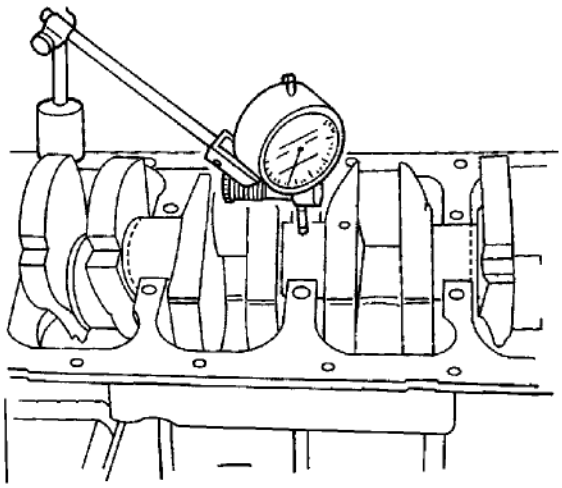
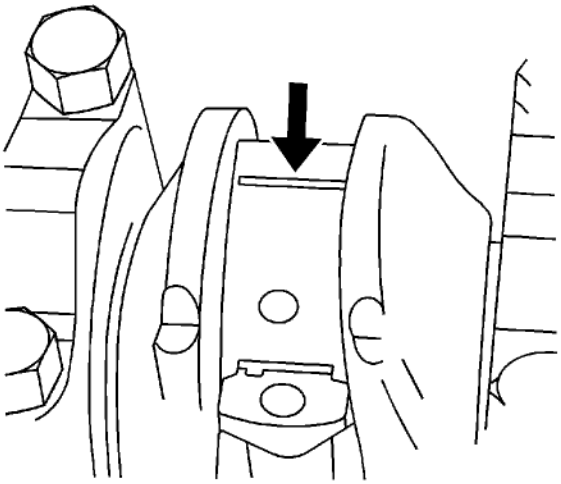
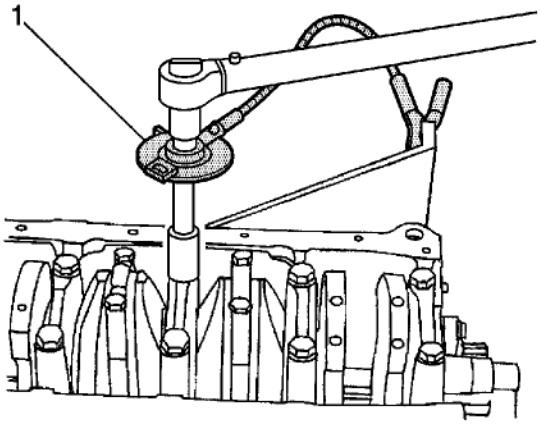


7. With the crankshaft mounted on the front and rear crankshaft bearings, check the middle crankshaft journal for permissible out-of-round (runout). Refer to Engine Mechanical Specifications.



Note: Grease the crankshaft journals and lubricate the crankshaft bearings slightly so that the plastic gaging thread does not tear when the crankshaft bearing caps are removed.

8. Inspect all of the crankshaft bearing clearances using a commercially available plastic gaging (ductile plastic threads).
9. Cut the plastic gaging threads to the length of the bearing width. Lay them axially between the crankshaft journals and the crankshaft bearings.

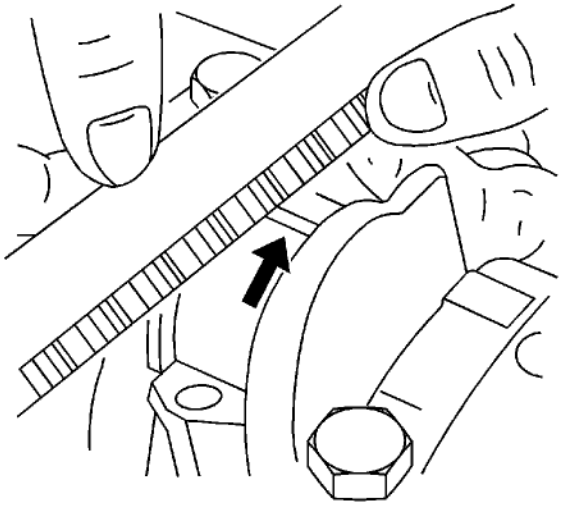


10. Install the crankshaft bearing caps.

Caution: Refer to Fastener Caution in the Preface section.

11. Install the crankshaft bearing cap bolts.

Tighten
Tighten the crankshaft bearing cap bolts to 50 N·m (37 lb ft). Using the J 45059 or KM-470-B (1) tighten the crankshaft bearing cap bolts 45 degrees plus 15 degrees.



12. Remove the crankshaft bearing caps.
13. Measure the width of the flattened plastic thread of the plastic gaging using the scale printed

on the plastic gaging package.

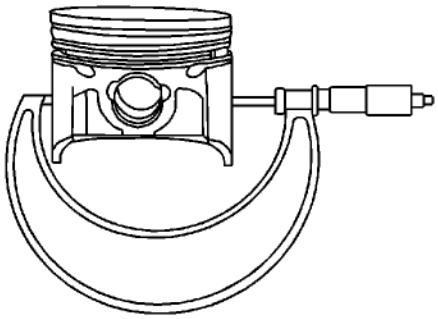
14. Inspect the bearing clearances for permissible tolerance ranges. Refer to Engine Mechanical Specifications.

Piston, Connecting Rod, and Bearing Cleaning and Inspection

Special Tools

- J 45059 Angle Meter
- KM-470-B Angular Torque Gage

Piston Inspection



1. Inspect the connecting rod for bending or twisting. If the connecting rod is bent or twisted, replace the connecting rod.
2. Inspect the connecting rod bearings.
3. Inspect the connecting rod lower end for wear.
4. Inspect the connecting rod upper end for scoring.
5. Inspect the crankshaft rod bearing journal for wear. Refer to Engine Mechanical Specifications.
6. Inspect the piston for scoring, cracks, and wear.
7. Inspect the piston for taper using a micrometer.

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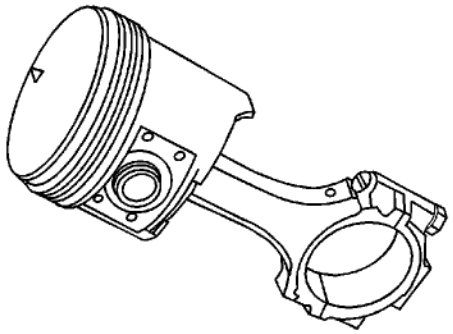
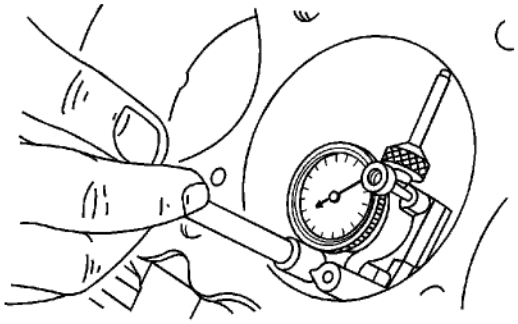


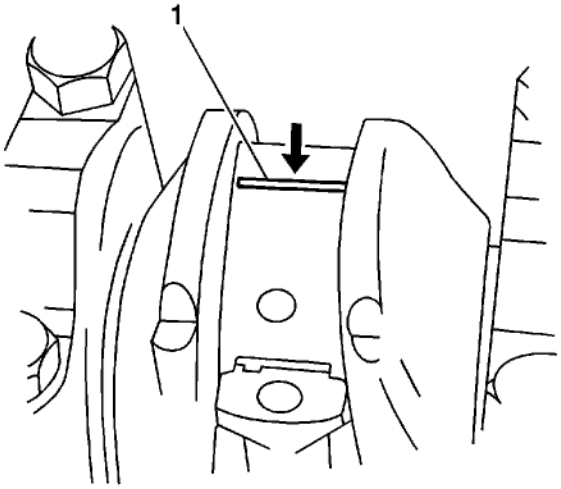
8. Inspect the piston for fit to the connecting rod.



9. Inspect the engine block deck surface for flatness using a straight edge and a feeler gage. Refer to Engine Mechanical Specifications.
10. Inspect the bearing bore for concentricity and alignment using a bore gage. Refer to Engine Mechanical Specifications. If the bearing bore is beyond specifications, replace the engine block.
11. Inspect the engine block cylinder bore for wear, runout, ridging and taper using a bore gage. Refer to Engine Mechanical Specifications.
12. Inspect the engine block cylinder bore for glazing.

Connecting Rod Bearing Inspection

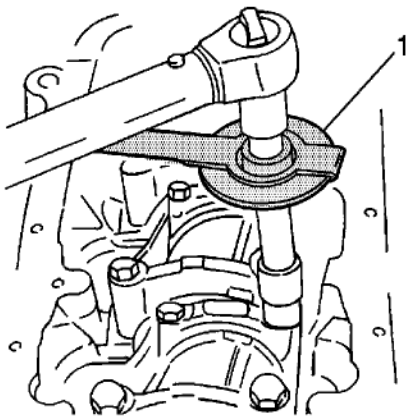
Warning: Refer to Battery Disconnect Warning in the Preface section.



1. Coat the connecting rod bearings with engine oil.

Note: Grease the connecting rod journals and lubricate the connecting rod bearings slightly so that the plastic gaging thread does not tear when the connecting rod bearing caps are removed.

2. Install the upper connecting rod bearings into the connecting rod journals.
3. Install the lower connecting rod bearings into the connecting rod bearing caps.
4. Measure all of the connecting rod bearing clearances using a commercially available plastic gaging (1), ductile plastic threads.



5. Cut the plastic gaging threads to the length of the bearing width. Lay them axially between the connecting rod journals and the connecting rod bearings.

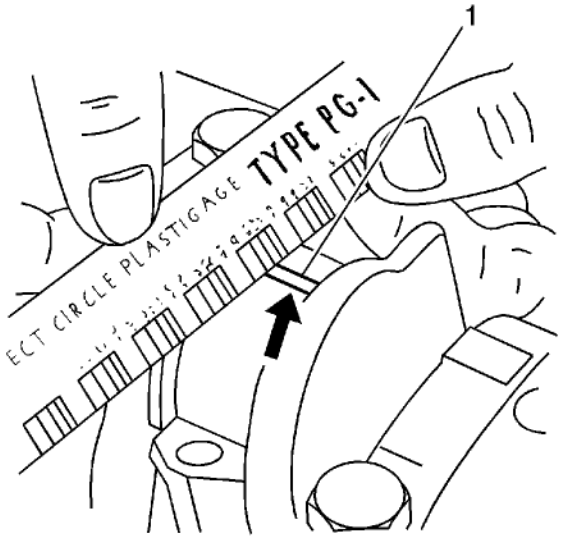
6. Install the connecting rod bearing caps.

   Caution: Refer to Fastener Caution in the Preface section.

7. Install the connecting rod bearing cap bolts.

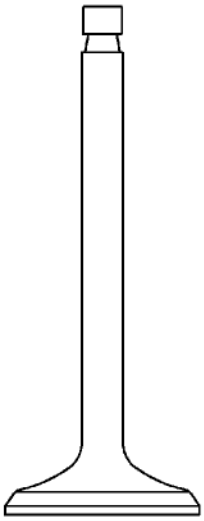
   Tighten
   Tighten the connecting rod bearing cap bolts to 25 N·m (18 lb ft).

8. Using the J 45059 or the KM-470-B (1), tighten the crankshaft cap bolts another 30 degrees plus 15 degrees.

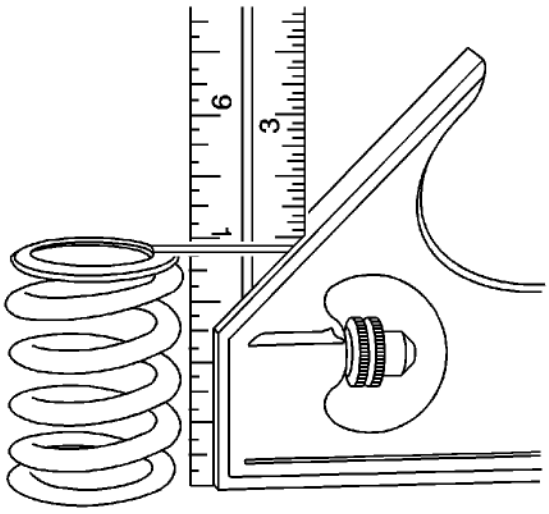


9. Remove the connecting rod bearing caps.
10. Measure the width of the flattened plastic thread of the plastic gaging (1) using the scale printed on the plastic gaging package. Plastic gaging is available for different tolerance ranges.
11. Inspect the bearing clearance for permissible tolerance ranges. Refer to Engine Mechanical Specifications.

Valve Rocker Arm Cleaning and Inspection



1. Inspect the valve stem tip for wear.
2. Inspect the valve key grooves and the oil seal grooves for chips and wear.
3. Inspect the valves for burns or cracks.
4. Inspect the valve stem for burrs and scratches.
5. Inspect the valve stem. The valve stem must be straight.
6. Inspect the valve face for grooving. If the groove is so deep that refacing the valve would result in a sharp edge, replace the valve.



7. Inspect the valve spring. If the valve spring ends are not parallel, replace the valve spring.

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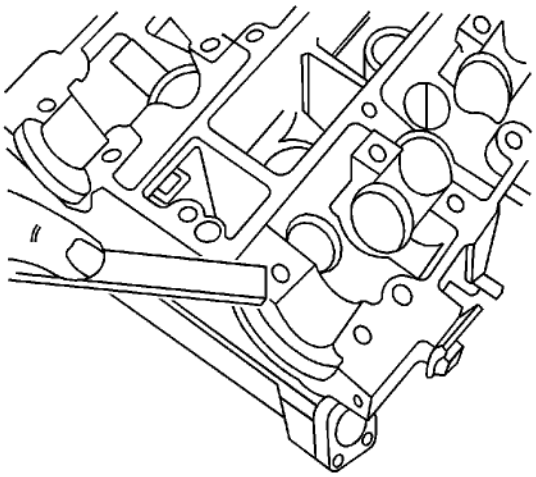
8. Measure the valve spring height. Refer to Engine Mechanical Specifications. If the valve spring height does not match the specifications, replace the valve spring.

Cleaning Procedure

Warning: Refer to Safety Glasses Warning in the Preface section.



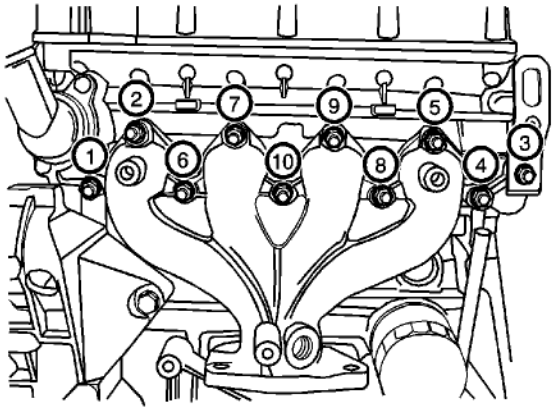
1. Clean the cylinder head.
2. Clean the valve guides.
3. Clean all of the threaded holes.
4. Clean the valves of carbon, oil, and varnish.

Cylinder Head Disassemble

Special Tools

- J 8062 (KM 348) Valve Spring Compressor
- KM-653-A Adaptor

Disassembly Procedure



1. Remove the cylinder head with the intake manifold and the exhaust manifold attached. Refer to Camshaft Replacement.
2. Remove the coolant temperature sensor (CTS).
3. Remove the exhaust manifold heat shield bolts.
4. Remove the exhaust manifold heat shield.
5. Remove the exhaust manifold retaining nuts in the sequence shown.
6. Remove the exhaust manifold.
7. Remove the exhaust manifold gasket.
8. Remove the exhaust manifold studs.

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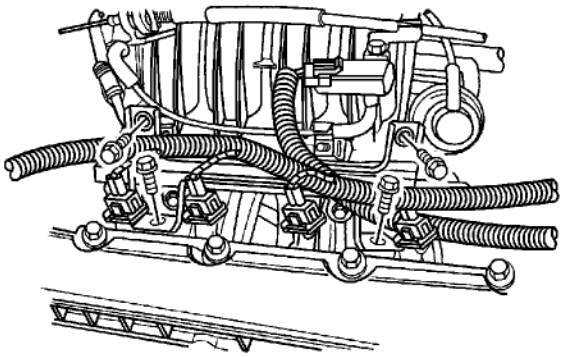
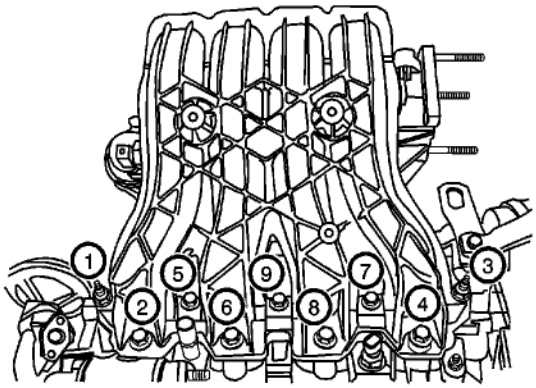
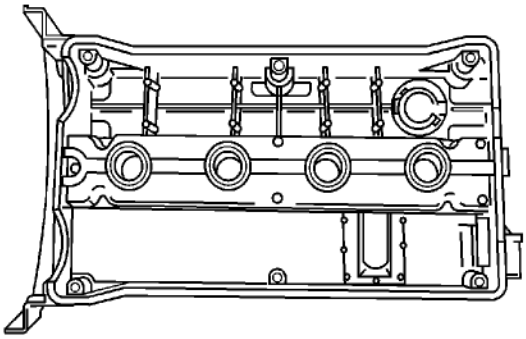


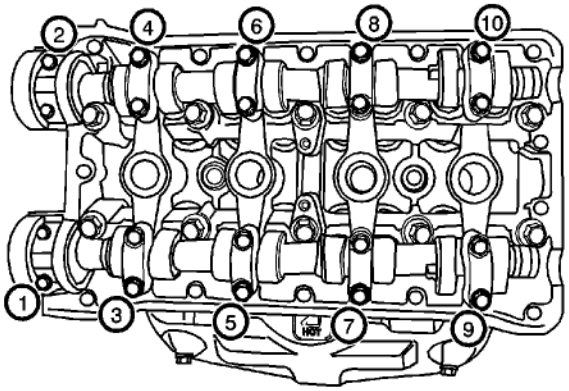
9. Remove the thermostat housing mounting bolts.
10. Remove the thermostat housing assembly.
11. Remove the fuel rail retaining bolts and the fuel rail assembly.



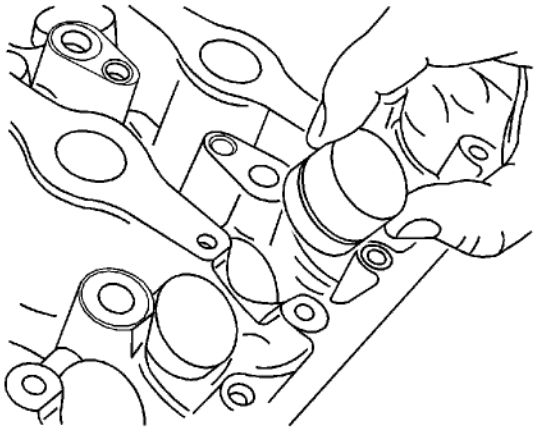
12. Remove the intake manifold retaining nuts and retaining bolts in the sequence shown.
13. Remove the intake manifold.
14. Remove the intake manifold studs.



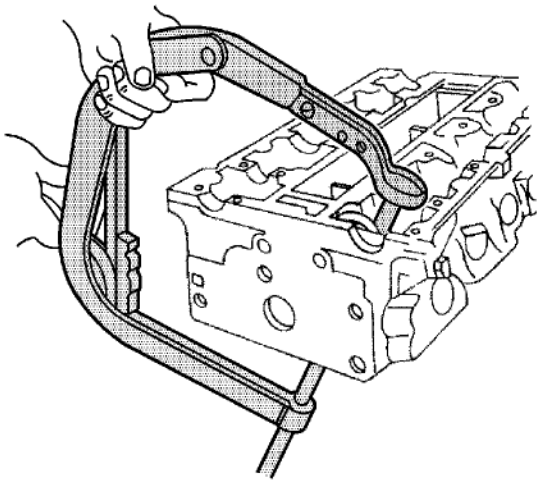
15. Remove the direct ignition system (DIS) coil mounting bolts.
16. Remove the DIS coil with the ignition wires attached.
17. Remove the DIS coil mounting bracket bolts.
18. Remove the electrical exhaust gas recirculation (EEGR) valve adapter bolts.
19. Remove the EGR valve adapter bolts.
20. Remove the EGR valve adapter.
21. Remove the EGR valve adapter gasket.
22. Remove the spark plugs.



23. Remove the camshaft cap bolts gradually and in the sequence shown for each camshaft cap.



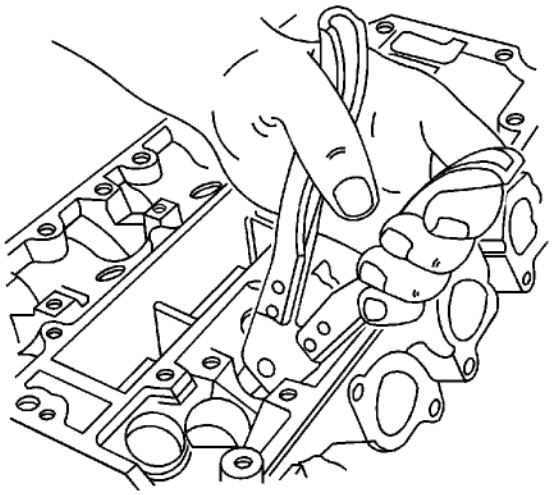
24. Remove the intake camshaft caps. Maintain the correct positions for installation.
25. Remove the intake camshaft.
26. Remove the intake valve tappet adjusters.
27. Remove the exhaust camshaft caps. Maintain the correct positions for installation.
28. Remove the exhaust camshaft.
29. Remove the exhaust valve tappet adjusters.
30. Remove the camshaft seals.



Warning: Valve springs can be tightly compressed. Use care when removing the retainers and plugs. Personal injury could result.

31. Compress the valve springs with J 8062 and KM-653-A .
32. Remove the valve keys.

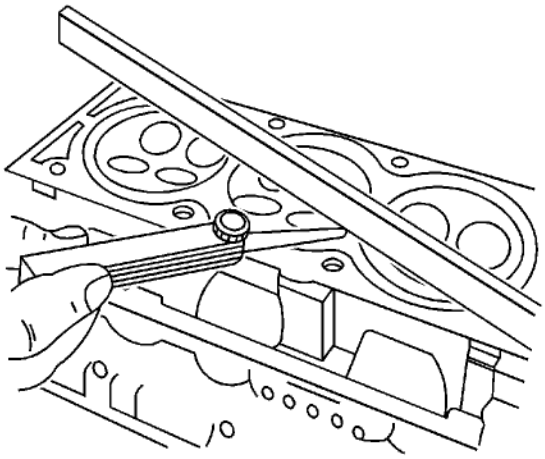
33. Remove the J 8062 and KM-653-A .
34. Remove the valve spring caps.
35. Remove the valve springs. Maintain the original position of the valve springs for installation.



36. Remove the valves. Maintain the original position of the valves for installation.
37. Remove the valve stem seals.

Cylinder Head Cleaning and Inspection (Off Vehicle)

Warning: Refer to Safety Glasses Warning in the Preface section.



Note: Machining of the cylinder head for flatness is not recommended as this would increase the compression ratio of the engine. If the flatness or height measurements are not within the specifications, replace the cylinder head.

1. Clean the sealing surfaces.
2. Inspect the cylinder head gasket and mating surfaces for leaks, corrosion, and blowby.
3. Inspect the cylinder head for cracks.
4. Inspect the length and the width of the cylinder head using a feeler gage and a straight edge.
5. Check the sealing surfaces for damage. The cylinder head sealing surfaces must be flat within 0.050 mm (0.002 in) maximum.

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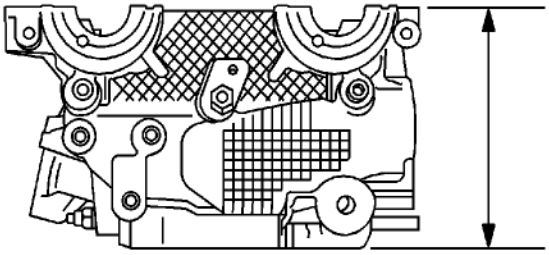
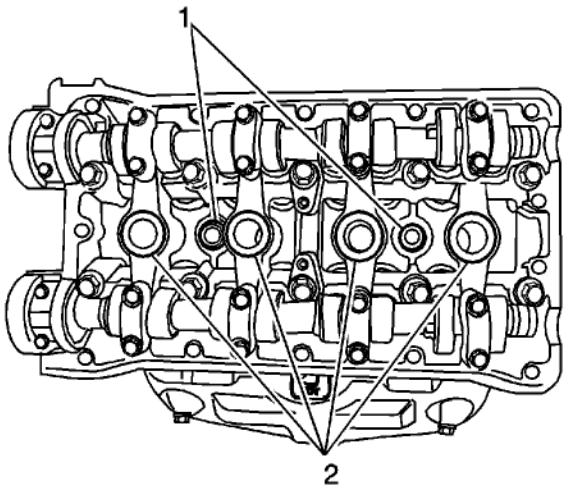


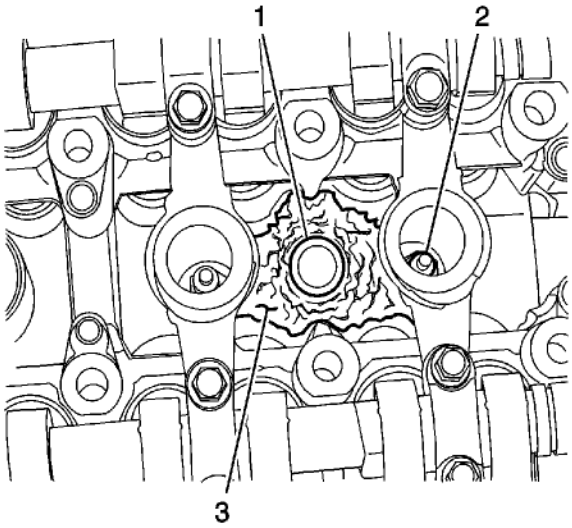
6. Measure the height of the cylinder head from sealing surface to sealing surface. The cylinder head height should be 138.13-138.18 mm (5.438-5.440 in). If the cylinder head height is less than this value, replace the cylinder head.
7. Inspect all threaded holes for damage.
8. Inspect valve seats for excessive wear and burned spots.

Cylinder Head Cleaning and Inspection (On Vehicle)

Warning: Refer to Battery Disconnect Warning in the Preface section.



1. Disconnect the negative battery cable.
2. Remove the valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement.
3. Locate the cylinder head casting (1) in the cylinder head between the spark plug holes (2).



Note: If the cylinder head casting plug is leaking coolant, it should have and sludge build up

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around the plug.

4. Inspect the area (3) around the cylinder head casting plug (1) for coolant leakage. Pressure test the cooling system if necessary.
5. If coolant leakage is identified, remove both cylinder head casting plugs.
6. Thoroughly clean the plugs and the cylinder head.
7. Apply Pipe Sealant with Teflon®, GM P/N 12346004, (Canadian P/N 10953480) to the plug threads.
8. Install the cylinder head casting plugs into the cylinder head

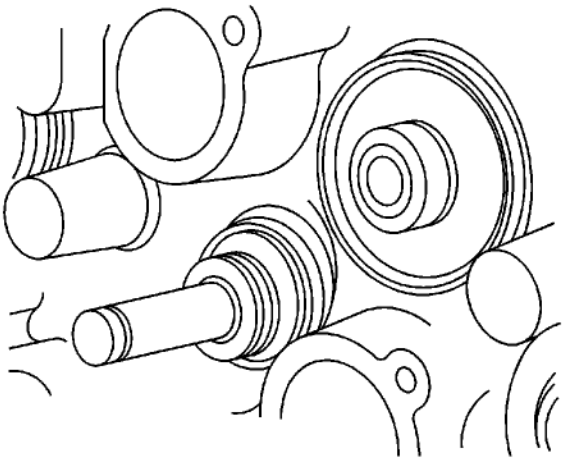
Tighten
Tighten the cylinder head casting plugs to 95 N·m (70 lb ft)

9. Install the valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement
10. Connect the negative battery cable.

Cylinder Head Assemble

Special Tools

- J 8062 Valve Spring Compressor -- Head Off
- KM-653-A Adaptor
- EN-48803 Camshaft Seal Installer



1. Install new valve stem seals.
2. Lubricate the valve stems with engine oil.
3. Carefully install the valves in their original positions. Do not damage the valve stem seals.
4. Install the valve springs in their original positions.
5. Install the valve spring caps.

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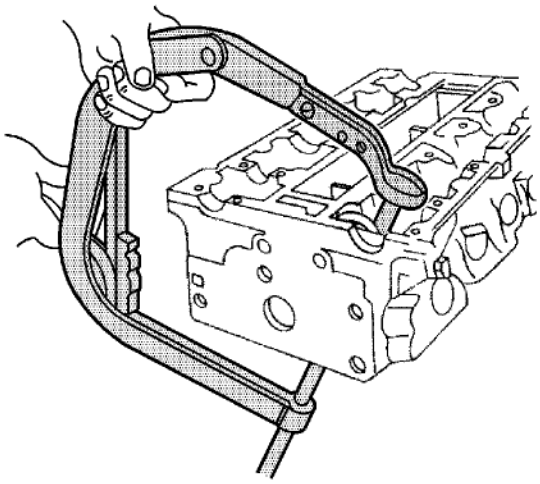
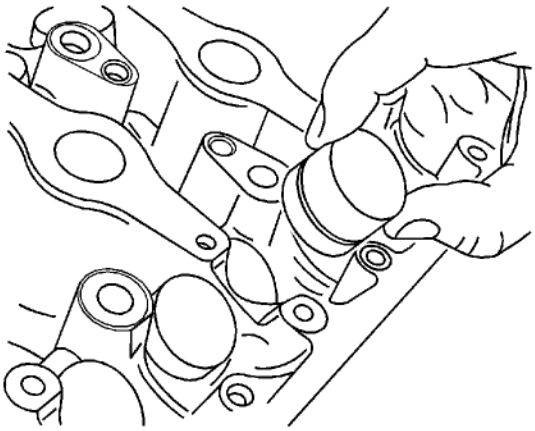
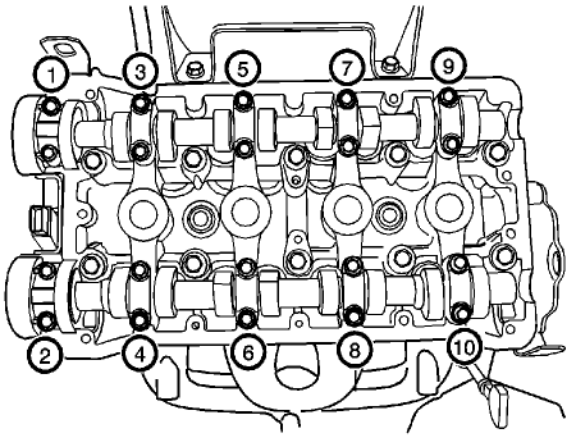


6. Compress the valve springs with J 8062 and KM-653-A .
7. Install the valve keys.
8. Remove J 8062 and KM-653-A .



9. Lubricate the valve tappet adjusters with engine oil.
10. Install the valve tappet adjusters.

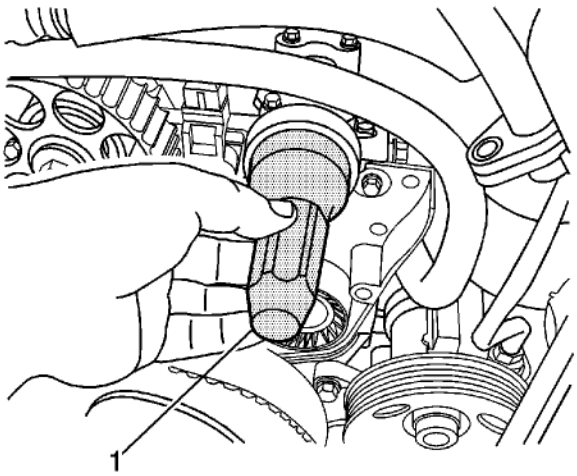


11. Install the intake camshaft.
12. Install the intake camshaft caps in their original positions.
13. Install the exhaust camshaft.
14. Install the exhaust camshaft caps in their original positions.
15. Install the camshaft cap bolts.

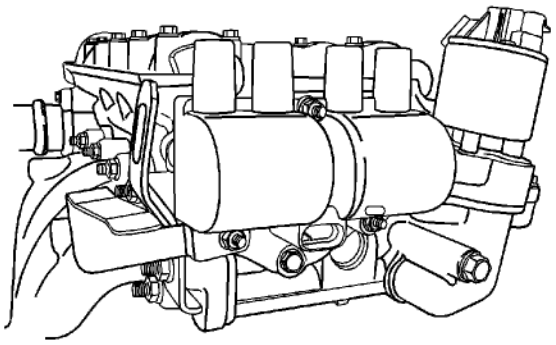
Caution: Refer to Fastener Caution in the Preface section.

16. Tighten the camshaft cap bolts gradually and in the sequence shown for each camshaft cap.

Tighten
Tighten the camshaft cap bolts to 16 N·m (12 lb ft).



17. Install new camshaft seals using EN-48803 .



18. Install the spark plugs.

Tighten
Tighten the spark plugs to 25 N·m (18 lb ft).

19. Install the exhaust gas recirculation (EGR) valve adapter gasket.
20. Install the EGR valve adapter.
21. Install the EGR valve adapter bolts.

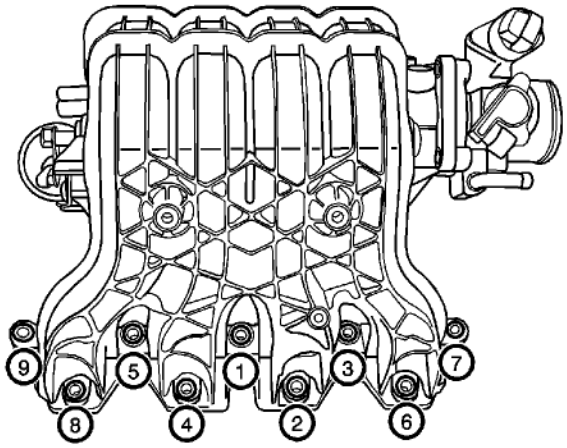
Tighten
Tighten the exhaust gas recirculation valve adapter bolts to 25 N·m (18 lb ft).

22. Install the direct ignition system (DIS) coil mounting bracket.
23. Install the DIS coil mounting bracket bolts.

Tighten
Tighten the direct ignition system coil mounting bracket bolts to 10 N·m (89 lb in).

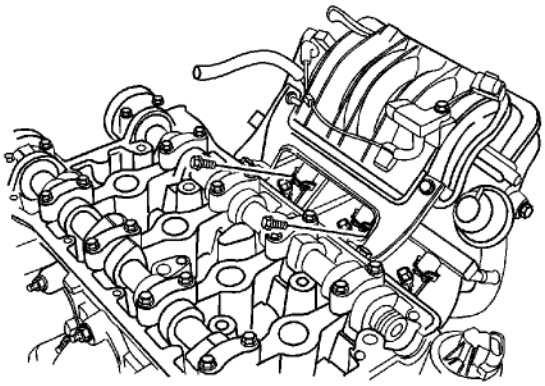
24. Install the DIS coil with the ignition wires attached.
25. Install the DIS coil mounting bolts.

Tighten
Tighten the direct ignition system coil mounting bolts to 10 N·m (89 lb in).



26. Install the intake manifold studs.
27. Install the intake manifold gasket.
28. Install the intake manifold.
29. Install the intake manifold retaining nuts and retaining bolts in the sequence shown.

Tighten
Tighten the intake manifold retaining nuts and retaining bolts to 25 N·m (18 lb ft).

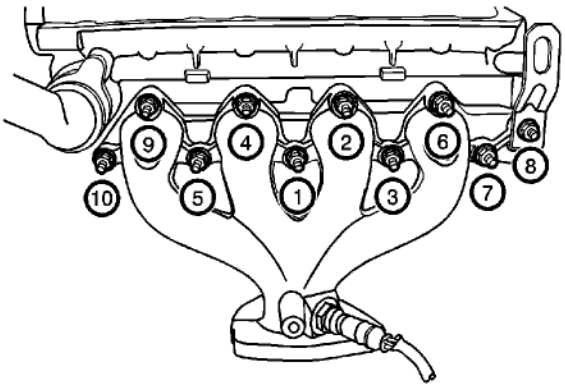


30. Install the fuel rail assembly with the bolts.

Tighten
Tighten the fuel rail assembly retaining bolts to 25 N·m (18 lb ft).

31. Install the thermostat housing assembly.
32. Install the thermostat housing mounting bolts.

Tighten
Tighten the thermostat housing mounting bolts 20 N·m (15 lb ft).

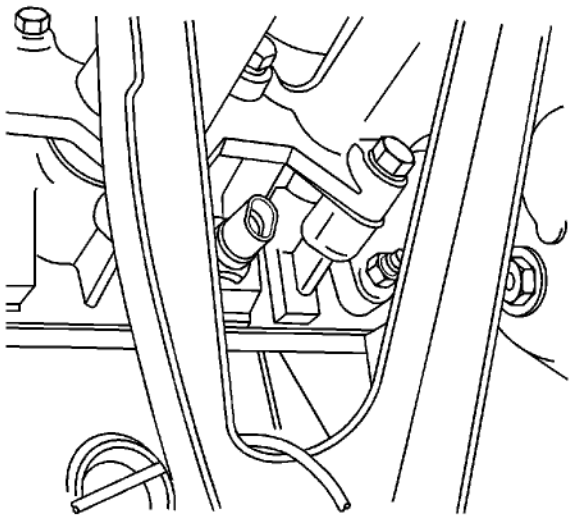


33. Install the exhaust manifold studs.
34. Install the exhaust manifold gasket.
35. Install the exhaust manifold.
36. Install the exhaust manifold retaining nuts in the sequence shown.

Tighten
Tighten the exhaust manifold retaining nuts to 25 N·m (18 lb ft).

37. Install the exhaust manifold heat shield.
38. Install the exhaust manifold heat shield bolts.

Tighten
Tighten the exhaust manifold heat shield bolts to 15 N·m (11 lb ft).

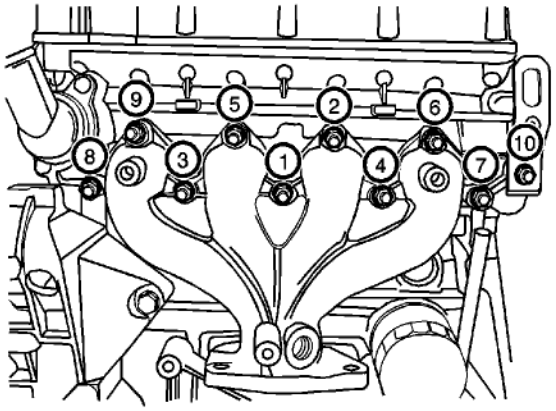


39. Install the coolant temperature sensor.

Tighten
Tighten the coolant temperature sensor to 20 N·m (15 lb ft).

40. Install the cylinder head with the intake manifold and the exhaust manifold attached. Refer to Cylinder Head Replacement.

Exhaust Manifold Installation

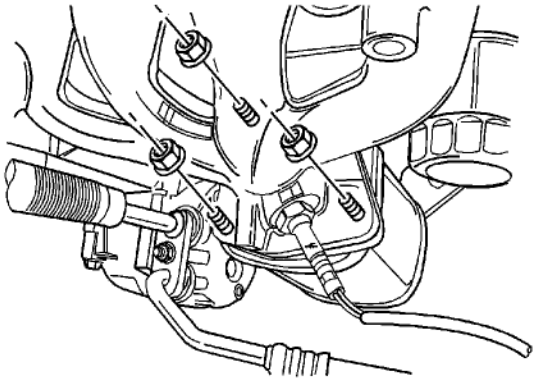


1. Install the exhaust manifold and gasket.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the exhaust manifold retaining nuts and tighten in the sequence shown.

   Tighten
   Tighten the exhaust manifold retaining nuts to 25 N·m (18 lb ft).



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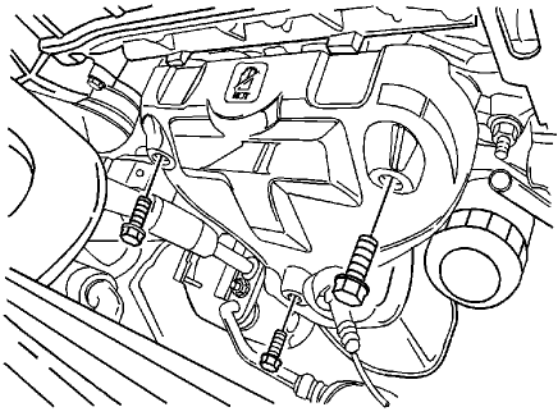
3. Install the exhaust manifold nuts to the catalytic converter.

Tighten
Tighten the exhaust manifold nuts to 40 N·m (30 lb ft).



4. Install the heat shield.

Tighten
Tighten the heat shield bolts to 13 N·m (10 lb ft).

5. Connect the oxygen sensor connector.
6. Connect the negative battery cable.